

TABLE OF CONTENTS

DIVISION 200 – EARTHWORK

SECTION 201 - CLEARING AND GRUBBING	3
201.1 – GENERAL	3
201.3 – CONSTRUCTION OPERATIONS	3
A. Clearing and Grubbing Trees and Stumps	3
B. Roadside Cleanup	4
C. Trimming of Trees	4
SECTION 202 – REMOVAL OF STRUCTURES AND OBSTRUCTIONS	4
202.1 – GENERAL	4
202.3 – CONSTRUCTION OPERATIONS	5
A. Demolishing Buildings	5
B. Signs and Other Traffic Control Devices	5
SECTION 203 – EXCAVATION AND EMBANKMENT	7
203.1 – GENERAL	7
203.2 – MATERIALS	7
203.3 – CONSTRUCTION OPERATIONS	7
A. Excavation	7
B. Subgrade and Slopes	8
C. Embankments	8
D. Disposal of Surplus and Waste Material	10
E. Borrow	10
F. Embankment-In-Place	11
G. Surcharges	11
H. Winter Construction Methods	11
SECTION 206 – STRUCTURE EXCAVATION FOR PIPES AND OTHER MINOR STRUCTURES	11
206.1 – GENERAL	11
206.3 – CONSTRUCTION OPERATIONS	11
SECTION 207 – CHANNEL EXCAVATION	12
207.1 – GENERAL	12
207.3 – CONSTRUCTION OPERATIONS	12
SECTION 209 – GRANULAR BACKFILL	13
209.1 – GENERAL	13
209.3 – CONSTRUCTION OPERATIONS	13
SECTION 210 – INSTRUMENTATION	13
210.1 – GENERAL	13
210.3 – CONSTRUCTION OPERATIONS	13
A. Settlement Platform	14
B. Vibrating Wire Piezometer	14

Division 200

C. Slope Inclinator	14
D. Permanent Bench Marks	14
E. Test Boring	Error! Bookmark not defined.
F. Tiltmeter	15
SECTION 214 – FINE GRADING	15
214.1 – GENERAL	15
214.3 – CONSTRUCTION OPERATIONS	15

SECTION 201 - CLEARING AND GRUBBING

201.1 – GENERAL

The clearing and grubbing operation is usually the first operation of construction. It consists of cutting trees and brush and grubbing stumps and roots where required within the limits of the project, but in no case beyond the applicable right-of-way and/or easements. This procedure may cause an unusual concern from the public due to the sometimes drastic change of the project. The project personnel must be prepared to answer any questions concerning rights of way, erosion control, or scope of the project prior to the beginning of this work. Where the clearing limits may affect screening or older individual trees it may be practical to discuss the operation with abutting landowners prior to commencement.

201.3 – CONSTRUCTION OPERATIONS

A. Clearing and Grubbing Trees and Stumps

Areas to be cleared; the limits of which are determined by checking the Plans (cross-sections), Specifications, and Special Provisions, should be laid out with colored flagging by the contractor, and field checked by the project personnel. Clearing and Grubbing is commonly measured by a final pay quantity. Any trees designated for removal under any other item are excluded from this work. Care should be taken by the Contractor to prevent damage to construction side stakes and to preserve all natural vegetation outside the clearing limits. Due to the growing concern about pollution, most construction projects have limits governing the land area of erodible earth material that may be exposed at one time. The project must have an approved “Erosion Control Plan”, Storm Water Pollution Protection Plan (SWPPP), and all required environmental documents prior to the start of any clearing and grubbing operation. Consult Section 645 and 699 of the Standard Specifications for information on this. In an effort to prevent stream damage and pollution, keep equipment out of live streams and be sure that all erosion control measures are in place prior to starting.

Clearing operations, particularly in dense and/or tall timbered areas, create hazardous conditions, and the project personnel should be careful when working in the proximity of cutting operations. It is also essential that the Contract Administrator review the Contractor's operations to determine if potential hazards exist that endanger the traveling public or existing facilities in or adjacent to the right-of-way.

Some trees and shrubs will be designated on the Plans to be saved. The contractor shall carefully protect and guard all trees, shrubs and vegetation, within or adjacent to the construction area that are deemed to be saved. Trees and shrubs not interfering with the project and within the clearing lines, particularly those adjacent to dwellings, should be reviewed by the Contract Administrator to determine if they can also be saved. Occasionally, valuable shade trees may be saved by the use of tree wells in fill sections or by warping the slope in cut sections. Check to see if trees that are designated to be cut, but could possibly be saved are especially valuable to the landowner. Trees and shrubs to be saved should be clearly marked by project personnel for identification purposes. The Contractor should be notified of the marked plants to save them from damage. Particular

attention should be paid to that portion of the Standard Specifications concerning the salvage of wood in the interest of conservation. Excavators or rake teeth on bulldozers should be used when grubbing to prevent excessive topsoil excavation during stump removal. If more than the normal amount of material is being removed, a deduction from borrow is warranted. Timber or other wood under 5" (125 mm) in diameter must be disposed of by chipping or other means of processing. All other trees, stumps, logs, branches, and brush shall be disposed of by the Contractor in compliance with applicable laws of the State of New Hampshire. The removal of stumps may not be necessary under fills of adequate depth. Consult the "New Hampshire Standards and Specifications for Roads and Bridges", section 201.3, for specific criteria concerning these areas.

B. Roadside Cleanup

This operation consists of the cleanup necessary to make an area outside the clearing limits appealing to the eye. During the clearing operations, dead or downed trees should be removed from the edge of the clearing limits. Ensure that the Contractor knows what he is expected to do.

C. Trimming of Trees

This phase of construction is usually conducted near the final stages of construction and is a force account item; therefore, this work should also be observed to ensure the most efficient use of time and equipment. Branches of trees damaged or extending into and over the roadway shall be carefully trimmed as directed by the Engineer. Be sure to view this work with future growth and changing seasons in mind.

SECTION 202 – REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.1 – GENERAL

This work shall consist of the removal, wholly or in part, and the satisfactory disposal of all buildings, including accessories and appurtenances, in accordance with the specifications, or as ordered by the Engineer. The Contract Administrator and project personnel should thoroughly study the Contract Plans, Special Provisions, and Right-of-Way Agreements for any special details pertaining to the removal of buildings, structures, fences, and other obstructions. The work to be done should be discussed with the Contractor's Superintendent to cover any details concerning salvage, storage, and disposal. Special attention should be drawn to the potential of asbestos and other hazardous materials that may be encountered. A receipt form as shown on the following page must be filled out and included in the Record Book as verification for all salvage materials and a manifest must be signed for hazardous materials. If the materials designated for salvage to the Department are refused by the bureau that was supposed to receive them than a General Note stating such must be included in the Project Record Book denoting how the material was disposed of.

202.3 – CONSTRUCTION OPERATIONS

A. Demolishing Buildings

The Contract Administrator should check salvage dates of buildings to be demolished subject to prior removal before the Contractor starts demolition. Usually, the time allotted ends before construction begins, but sometimes circumstances extend dates into contract time and the owner may still have legal possession. The burning of buildings is generally unacceptable. Prior to any act of demolition, be sure all aerial and underground utilities, electric, gas, telephone, and water, have been disabled by their appropriate companies. Check with the associated city or town to assure any municipal requirements for utility termination have been followed. All materials resulting from the demolition, unless specified, shall become the property of the Contractor, and shall be disposed of in accordance with all applicable laws, rules, and regulations. Once the work has commenced, the Contractor shall make every reasonable effort to demolish the designated structure in a manner that will insure the safety of the project personnel and the public.

B. Signs and Other Traffic Control Devices

Where traffic control signs or other devices are located within the excavation limits, the proper authorities should be notified prior to the start of work to have the signs and control devices removed or relocated. If it is necessary for the Contractor to start construction operations in the area where signs are to be removed, then request that the Contractor removes them carefully, without damaging the signs, and store them outside the excavation limits. Private advertising signs also may need to be removed. Check with the District Construction Engineer if disposition through Right-of-Way agreements is not available.

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION
BUREAU OF CONSTRUCTION

DATE: April 2, 1997

Contract: Laconia

State No.: 99999

Federal No.: NHS-018-2(104)

The undersigned acknowledges receipt of the following materials/equipment from the above referenced contract in compliance with the Contract Plans and Specifications:

Granite slope curb, 250'
Grate and Frame, Type C, 3 each
Standard Beam Guardrail w/posts and hardware, 150'
Portable Concrete Barrier, 300'

Received by:

Signature: John Dell

Name: John Dell

Title: Highway Patrol Foreman

Organization: NHDOT Dist. 6 Maintenance

Date Received: April 3, 1997

Destination: Patrol Shed #699

Compiled By: Ronald Tanner
Ronald Tanner, Contract Administrator

SECTION 203 – EXCAVATION AND EMBANKMENT

203.1 – GENERAL

This work shall consist of excavating or placing material in reasonably close conformity with the lines, grades, and typical cross sections shown on the plans or specified by the Engineer. Operations involving roadway excavation and fills, including placing, compacting, and finishing of the excavated material in the embankments, are among the most common operations in highway construction work. The bulk of the inspector's duties and responsibilities are the inspection and control of materials and the inspection of excavation and embankment grading operation procedures. The Contract Administrator and project personnel must realize that quality constructed embankments and subgrade are essential to the overall performance and quality of the base course and pavement structure.

203.2 – MATERIALS

Sufficient classification of materials is given in the Standard Specifications.

203.3 – CONSTRUCTION OPERATIONS

A. Excavation

The Contractor shall never excavate or remove any material outside the limits indicated on the plans. The Specifications do not allow payment for materials excavated beyond the limits of the required slopes, except in certain specified instances. If at any time the Contractor excavates outside the slope limits or below subgrade, the Contract Administrator shall immediately notify the Contractor in writing that the Specifications do not permit payment for such excavation. When the Contractor excavates below subgrade, the excavated material shall be replaced with a material of equal or better quality. Before the work is accepted, the roadway shall be substantially true to line, grade, and section as shown on the Plans.

In all cuts, slope grade stakes should be required throughout stages of excavation to ensure as little slope variation as possible.

When rock is encountered, a NHDOT survey party should be obtained as soon as the earth overburden has been satisfactorily removed so cross-sections may be taken before drilling operations begin. The interval of stationing may vary with substantial change in rock outcropping, but should normally be at 25 ft (10 m) intervals.

The Contractor shall submit a blasting plan to the Contract Administrator, for approval, 2 weeks prior to commencing drilling and blasting operations. Careful control and detailed documentation of blasting activities is recommended, including location, time, amount of explosives, etc., to cope with problems that often arise as a result of alleged blasting damage. A detailed blasting report

including video and vibration monitoring is often required from the contractor. Signals for blasting should conform to rules and regulations as stipulated in the Federal Register. Check to see that air pollution regulations are being followed during drilling operations.

When excavating for drives, check the profile grade to see that it doesn't exceed the maximum allowable value.

Muck excavation limits should be reviewed and established according to Plan depths or field probing when feasible. Final sections should be taken immediately after satisfactory removal and checked against Plan depths so adjustments in width can be made before equipment has advanced.

B. Subgrade and Slopes

Before placement of base materials on the subgrade, the entire roadbed should be checked to make sure it substantially conforms to the typical cross section and required grade. Any unstable areas should be corrected by aeration or removal and replacement. In excavation areas, water seepage may show up either at subgrade or through slopes. Underdrain may be needed to remove water at normal underdrain depths in the subgrade, and gravel or ledge cores may be needed to stabilize slopes. In either case, notify the District Construction Engineer of expected additional work. This additional work should be discussed immediately at the first signs of an unstable situation.

C. Embankments

The supporting strength of the soils in embankments is directly affected by compaction. Improperly compacted embankments will further consolidate under traffic and result in an uneven road surface. Care must be taken to ensure that uniform density is obtained throughout the embankment. Full width embankment construction in horizontal layers of uniform thickness should be encouraged where possible. This will ensure a more uniform density throughout the fill, including the outer edges of the embankments. It is also essential that the moisture content be uniform. In most cases, the required density can be obtained with the least effort if the moisture content is close to the optimum as determined by the standard moisture-density (proctor) test. In general, the moisture content required for compaction should approximate the optimum moisture content obtained from laboratory (proctor) tests. Materials having a high percentage of fines are susceptible to over watering. When saturated, the fines develop properties of fluids, and as such produce an unstable embankment. Therefore, such over watering should be avoided. The most efficient use of water in obtaining compaction is attained by uniform distribution of the water throughout the entire surface area of the fill.

The choice of compaction equipment is usually left to the Contractor, but the following table is a good guide to the types of equipment suited for compacting soils.

Type of Compactor	Soil best suited for	Maximum effect in loose lift (in)	Density gained in lift
Sheep's Foot	Clay, silty clay, gravel with clay binder	6" – 12"	Nearly Uniform
Steel tandem two-axle	Sandy silts, most granular materials with some clay binder	4" – 8"	¹ Average
Steel tandem three-axle	Same as above	4" – 8"	¹ Average
Pneumatic, small-tire	Sandy silts, sandy clays, gravelly sand and clays with few fines	4" – 8"	¹ Average to uniform
Pneumatic, large-tire	All types	up to 24"	Uniform
Vibratory	Sand, silty sands, silty gravels	3" – 6"	Uniform
Combinations	All	3" – 6"	Uniform

1. The density may decrease with depth

Source: Peurifoy, R.L. *Construction Planning, Equipment, and Methods*, Third Edition, McGraw-Hill Book Company.

One of the main difficulties that the project personnel will encounter in constructing embankments will be that the rate of placing material in the fill area may far exceed the compacting capacity of the Contractor's equipment. In this case, the Contract Administrator should not hesitate to require that either the amount of hauling equipment be decreased or the amount of compaction equipment be increased to the point where each layer is satisfactorily compacted before any material for the succeeding layer is placed. When end dumping is employed embankment material shall be dumped on the layer of embankment being constructed and pushed ahead into place. End dumping off the end of the lift or into piles is not permitted.

Lift depths shall be controlled as stated in the Specifications to ensure proper placement of rock and earth as they are used in the fills. Do not let larger boulders control the depth of lift, as these boulders can be utilized at the toe of slope for slope protection or, if necessary, broken up.

Make sure the shape and grade of the embankment conforms to the template as fill progresses by checking and assisting the Contractor with sufficient line and grade. It is the responsibility of the Contractor to see that slope stakes are properly set. Under no conditions should the construction of fill slopes be permitted until slope stakes have been set at the toe of the slope and checked. Generally the clearing limits should be 5' beyond the toe of slope, and 10' beyond the top of slope.

The Contractor shall also be required to set such intermediate working stakes as may be necessary to maintain true lines.

Should the Contractor construct unauthorized fattened slopes, the excess material should immediately be ordered removed. If the Contractor fails to remove the material in question, make certain documented information is available to plot slope lines on the template so a quantity can be calculated and deducted from borrow.

The procedure for density requirements and tests is adequately covered in the Specifications, with the exception of the frequency of the tests by project personnel, which is covered in the "NHDOT Guide to Frequency of Sampling and Testing" in Division 700 of this Manual. The recommended rate is one test per 12" (300 mm) lift per 1500' (500 m) in length. This means that a 750' (250 m) long fill requires one compaction test for each 2 lifts. This is an average frequency for testing. At the start of the project, more tests may be needed to determine what procedure will be needed to obtain the required density. Once this is determined, fewer tests may then be needed to maintain control of the fill material.

Independent Assurance Tests are to be made by the Materials and Research Bureau personnel at the rate of one test per 32,500cy (25,000 m³) of embankment or one per project by observation or comparison.

D. Disposal of Surplus and Waste Material

The Specifications define what surplus and waste materials are and how they are to be disposed of. In no case should waste be placed in any type of disposal area in such a manner as to be unsightly, nor should it be placed such that it ponds water. Such material may be utilized to flatten slopes and eliminate guardrail if authorized by the Contract Administrator. All off site disposal of surplus and waste materials requires a NHDOT disposal agreement. You should reference the disposal agreement for requirements and any additional information.

E. Borrow

The Contractor should not be permitted to place borrow until the excavation is nearly completed, unless it is necessary to provide for staged construction or for the maintenance of traffic.

F. Embankment-In-Place

Embankment-in-place involves the placing and grading of material in an embankment from excavation or borrow sources and is an in-place quantity. No separate payment is made for materials taken from borrow areas that are needed to complete the embankment. Common excavation and other items involved are constructed under their appropriate Item.

G. Surcharges

Surcharge content is that portion of the embankment that is placed above the intended subgrade for the purpose of increasing the rate of settlement. The surcharge area should be sectioned just prior to removal to record the behavior and to determine quantity. The surcharge material, when removed, should be transported to specified or predetermined areas.

H. Winter Construction Methods

Embankments constructed during winter conditions are to be carefully inspected as stated in the Specifications to ensure that frost is not incorporated into the work. If any frozen material is observed it must be removed before any new material is placed.

Muck and ledge excavation are common winter operations that are not affected by frost.

Muck areas can also be backfilled with ledge or other approved material during winter operations without negative effects where backfill is in water.

SECTION 206 – STRUCTURE EXCAVATION FOR PIPES AND OTHER MINOR STRUCTURES

206.1 – GENERAL

Structure excavation consists of the removal and backfill of material necessary to complete the installation of pipes and other minor structures as described in the Specifications.

206.3 – CONSTRUCTION OPERATIONS

The Specifications and Special Provisions should be checked for the requirements of this Item. Special attention should be given to the applicable safety manual governing the necessity of shoring and bracing and for reference to the general safety requirements of the workers. A good manual is the *Safety and Health Requirements Manual*, No. EM 385-1-1, published by the U.S. Army Corps of Engineers. Material that is excavated should be examined before being used for

backfill. If the material cannot be used for this purpose it should be used in embankment construction, or, with the permission from the Contract Administrator, it may be wasted if it is unsuitable for any use. Any material wasted by the Contractor without permission should be deducted from borrow, if the borrow item is included in your contract.

Section 603 of this Manual should be consulted for information regarding structure excavation when in conjunction with culverts and storm drains. Additional information may also be found in sections covering the item of work with which structure excavation is included.

SECTION 207 – CHANNEL EXCAVATION

207.1 – GENERAL

Channel excavation is that work done in the construction of a new or altered waterway usually in conjunction with construction of a structure.

207.3 – CONSTRUCTION OPERATIONS

Offset stakes with grades should be provided along with cross sections of existing ground as close to the time of excavation as is feasible. Final cross sectioning should follow the completion with as little time lapse as possible. If there is to be a considerable amount of time between starting and completion of channel excavation, such as over the winter, intermediate or semifinal sections should be taken to avoid questions later as to whether any material moved is a result of erosion or Contractor operations. The method of construction is usually left to the Contractor as long as the finished channel is in accordance with lines, grades, and cross sections indicated on the Plans, or as ordered. The Contract Administrator should be sure that the Contractor knows how the excavation is being measured, either by original and final sections or by paying to an established template.

The determination and implementation of appropriate erosion control measures will be completed before any work begins. These measures should be reviewed with the contractor and plan preparer. Care should be taken to ensure that stream pollution due to turbulence and erosion is kept at a minimum during excavation operations. The wetlands permit should be reviewed to ensure the impact areas shown on the permit will not be exceeded and permit conditions are complied with. The project erosion control plan should address the erosion control measures required for this work.

SECTION 209 – GRANULAR BACKFILL

209.1 – GENERAL

This section covers the furnishing and placing of special purpose backfills where called for on the Plans or as ordered. Granular backfill and granular backfill (bridge) are the two basic Pay Items.

209.3 – CONSTRUCTION OPERATIONS

The Specifications and Special Provisions should be checked concerning construction operations when backfilling structures, culverts and storm drains, structural plate pipes, pipe arches, and other items. The backfill material should not be placed in lifts exceeding that specified and should, in the case of pipes, be brought up evenly on both sides at the same time. When backfilling structures, a method of checking lift depths is to actually mark the concrete with the correct increments. As material is being placed and compacted, a sufficient number of density tests should be conducted to ensure compliance with Specifications. Compaction operations using vibratory rollers should be carefully watched in order to prevent possible movement of structures due to over-vibration. A recommended procedure is to perform a test strip by take extra density tests at the start of the backfill operation to determine the exact number of passes needed by the vibratory roller to achieve the required density. No more than this required number should be allowed unless additional density tests indicate the need for a change. Puddling should be avoided due to the excessive fluid pressures placed on the structure, but to achieve the required uniform density, water is usually required to keep the soil near its optimum moisture.

SECTION 210 – INSTRUMENTATION

210.1 – GENERAL

This section covers furnishing, installing, maintaining, and protecting Geotechnical Instrumentation where called for on the Plans, in the Contract or as ordered. The Special Provisions describe the requirements for the instrumentation called for on your project. Most instrumentation requires close cooperation with the Geotechnical Section of the Materials and Research Bureau. Data collected in the field is often sent to Materials and Research for interpretation. The Contract Administrator should work closely with the Geotechnical Section in order to assure all phases of inspection are complete, whether by Materials and Research or Construction personnel. The Contract Administrator should also make clear when and how data will be collected, recorded and processed.

210.3 – CONSTRUCTION OPERATIONS

A. Settlement Platform

Settlement platforms are used to monitor settlement of a compressible layer such as clay. Clay is made up of fine particles of hydrous minerals. The consolidation of clay is a time dependent process as the water is slowly “squeezed” out of the material. The time for consolidation can be predicted by design engineers based on the clay properties and the distance the water needs to travel to get out of the clay. Wick drains and sand blankets are often installed to reduce the distance the water needs to travel therefore increasing the rate of consolidation. The consolidation begins as the clay layer is loaded with embankment material or in the case of some structures preloaded or surcharged. Settlement platforms are installed and monitored to provide the Geotechnical Engineers with the rate of settlement of the clay layer so that they can accurately determine when the clay has consolidated enough and construction can continue.

The Contract Administrator should stress to the Contractor the importance of maintaining the correct elevation on the riser pipe of the settlement platform. Once the bottom elevation is determined a file mark should be marked near the top (but below the threads) of the first riser pipe at an even elevation. This mark should be transferred upward from riser pipe to riser pipe as the fill progresses so that there is always a visible mark of known elevation. Care must be taken to ensure the riser pipe remains plumb and not disturbed by the settling process.

B. Vibrating Wire Piezometer

Vibrating wire piezometers are used to measure pore water pressure in compressible clay layers typically below fills and embankments. The Special Provisions should be checked carefully to ensure the Geotechnical Section of the Materials and Research Bureau is notified early enough to check and calibrate the piezometers prior to installation. They also need time to schedule inspection of the piezometer installation.

C. Slope Inclinometer

Slope inclinometers consist of a casing placed into a borehole. The space between the borehole and the casing is filled with grout per the Special Provisions. The casing has grooves at 90 degrees that accept a calibrated wand that measures any horizontal deviation in the casing. After baseline information is collected the inclinometer will indicate any horizontal movement of the soil into which it is installed. As with all other instrumentation careful coordination with Materials and Research Bureau is required.

D. Permanent Bench Marks

Areas subjected to settlement may influence conventional survey benchmarks. Permanent benchmarks may be constructed that are founded on a suitable bearing stratum such as ledge. The permanent benchmarks can be used to monitor settlement platforms, and provide construction elevations with confidence.

E. Test Borings

Test borings are used to provide necessary geotechnical information as the project progresses. Some construction procedures compact the existing soils and it is necessary to confirm that the proper soil compaction has been achieved. The Materials and Research Bureau must be notified prior to test borings as described in the Special Provisions.

F. Tiltmeter

Tiltmeters can be used to measure tilt in structures such as bridges and retaining walls.

The Materials and Research Bureau specifies different types of instrumentation to meet specific site requirements. The effectiveness of the instrumentation requires careful, precise installation by the Contractor and diligent inspection on the part of the Materials and Research Bureau and/or the Contract Administrator and Project Personnel.

SECTION 214 – FINE GRADING**214.1 – GENERAL**

Fine grading is the grading necessary to prepare the subgrade for the base material, to prepare each base material for the succeeding course, and to prepare the final course for pavement, including shoulders. Due to the addition of QC/QA paving the importance of a good fine grading job has increased greatly. The project personnel must be aware that per specification, the finished surface shall be uniform, true to grade, and free from segregation. This fact should be documented in the project daily reports, and/or record book. A discussion on the fine grading between the prime contractor, the paving contractor, and the contract administrator is also recommended prior to starting any paving operation. Also included is the final grading of the balance of the roadway from the shoulders to the top or toe of slope.

214.3 – CONSTRUCTION OPERATIONS

The importance of a well-prepared subgrade cannot be overemphasized. Finished subgrade must be compacted with final densities taken and must be geometrically correct before any base course materials are applied. Good control of the application of base course materials can be achieved by reproducing the centerline with stakes at centerline or outside the limit of grading, or at both the centerline and outside the limit of grading, and the project personnel should check the grades of the stakes set by the Contractor by the use of a transit (level) and level rod. The use of side stakes for this stage of construction should be used only for relatively low grade roadways with small cuts and fills. Checking the surface of a previously placed base course is usually conducted by stretching a string on grade

from stake to stake across the road and measuring down with a rule to determine if the required template has been constructed.

Prior to fine grading the final course of a foundation material, the following checks should be made:

1. Check for contamination of the surface from spillage or tracking in of foreign material. Any contaminated gravel should be removed and replaced.
2. Check for degradation of the material due to traffic. Samples of the top 3" or 4" (75 or 100 mm) will determine the amount of degradation and indicate whether the correction can be made by scarifying and mixing or whether it will be necessary to remove and replace the affected material to produce a satisfactory uniform gradation.
3. Check for hard compacted surfaces. Where the fine grading for pavement does not directly follow the placing and initial compaction of the material, the surface usually becomes hard packed, glazed, and pot-holed from traffic or the Contractor's equipment. These areas must first be scarified for the full width of the traveled way and to a depth below any low spots, or the finished fine graded surface, whichever is lower. This will result in an evenly compacted surface that is one important link in the construction of a good riding surface.

The final course of base material is fine graded through the use of "blue tops" which should be used on all main line work, unless the fine grading is completed by the use of automation. In this case usually one grade line will be set first then the automation sensor on the grader will refer to this grade line and electronically create the appropriate cross-slope. Blue tops are short, hard, wooden stakes with "feathers" which are driven into the material to be fine graded. Blue tops are driven so that the elevation of the top represents the grade for its precise location. Compute the actual grades at all points where blue tops are to be set, which are usually at the centerline and at the edge of the pavement or 12" (300 mm) beyond the edge, with additional points every 12 ft (3.6 m) in width for wide areas, and at important pavement locations such as pavement breaks. See that the contractor is properly driving the blue tops. They should only be set when the final course is up to grade or a little above grade and properly compacted. It should normally be necessary to use a bull point to insert the blue tops; if this is not the case, then the material is not fully compacted. Be sure that the bull point does not create a hole deeper than the blue top. This will result in a lower elevation than the plan as the grader works the area. The grader operator then cuts the roadway to the top surface of the blue tops. This produces a surface that is true to grade and template. Although the "feathers" were originally painted blue, from which they were named, the blue tops are now usually painted red or some other bright color so that the grader operator can easily spot them. Since blue tops are repeatedly being covered during fine grading operations, it is essential that a laborer find the blue

top and repaint them. Risers set 3 ft (1 m) off the edge of the pavement and graded may be used to check the blue tops, if one is driven down by the roller, or to replace one ripped out by the grader. The risers also provide a means of checking blue top grades by stretching a string across the road and measuring down. Generally blue tops checked within a ¼" of the plan elevation are acceptable. On critical areas such as a flat grade to a drainage structure tighter limits may be warranted.

Checking grade and cross-slope for an automated fine grading operation can generally be completed in the same fashion. It is important to check the elevation of the string line or other reference data at the beginning of the grading operation. Make sure that the graders automation equipment is running properly at all times. Make sure that the grader operator is provided the correct cross-slope information, paying particular attention to variations from the typical section. Assuming the elevations are correct, spot-checking the cross-slopes can easily be done in a number of ways. The use of automatic levels, hand levels or smart levels can be utilized. If help is needed, it is in Contractors best interest to provide assistance while the Department performs any check and the usually will do so if proper planning is done.

Proper available equipment is also an important factor when fine grading. A grader must be in good mechanical condition with the cutting edge in good shape, tight control arm joints, and a snug-fitting circle. A roller and a water truck must also be in good mechanical condition. Meet and work with the grader operator. No two are alike, but most of them want to produce a well riding road. Get used to the operator's system and explain what is required for the finished product. Check and recheck for grade and cross slopes as the work continues down the road. See that the operation is set up so that the grader will be working ahead and the water truck and rollers following behind. Rubber tires, whether on a roller or on traffic, will give better compaction faster, but for a smooth and uniform surface the steel wheel roller should perform the finish rolling to drive down the protruding stones and take out small ridges.

Highly satisfactory results on some projects have been achieved through the painstaking efforts of the Contract Administrator and the project personnel. Such results can only be obtained through constant checking and rechecking of cross slopes and grade with blue tops and by eye, repetition of fine grading operations, the elimination of soft spots through adequate watering and rolling, continued checking of compaction of all select materials, and above all the continuation of these operations for an adequate length of time. The Contract Administrator, and project personnel check the uniformity of grades between stations. This is done by getting close to the surface and looking along the grade. When conditions permit, the Contract Administrator should also drive a car over a completed section of crushed gravel at design speed to check for smoothness, side motion, or any other unusual effect that requires closer scrutiny.

Most Contractors Superintendents feel that psychologically they have the Contract Administrator in a corner when the paver, sizzling at the end of a strip of gravel, waits for the word to go ahead. It is recognized that such pressure can be enormous. It is important to stress to the Prime Contractor, and the Paving Contractor that the commencement of paving operations is upon approval of the Contract Administrator. However, if proper results are to be obtained this procedure will go smoothly. Remember that a few extra hours spent at this time will be reflected in a good riding surface for years to come.

It should also be noted that gravel shoulders, slopes, and ditches should conform to the lines as shown on the cross sections, which is usually achieved by the use of machinery supplemented by hand labor. These areas should present an attractive appearance free of puddles, stones and roots.